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METALLURGICAL TESTWORK-

03/005/006 - SULFIDE HEAP LEACH TEST (SEPT 1992)
-TO CENTRAL FILES

Chamberlin & Associates

7463 W. Otero Place
Littleton, CO 80123
Tele & FAX 303-979-6753

December 13, 1993

Mr. Martin Quick
Dakota Mining Corporation
410 17th St., #2450
Denver, CO 80202

Dear Mr. Quick:

I have reviewed the gold extraction curves for the sulfide heap test at Gilt Edge as prepared by the project's metallurgist, Laura Damon. In summary, the curves for Models #1 and #3 are correct and defensible. Gold extraction will be between 57% and 62% after two years of leaching; in my opinion it will be closer to 62%.

Several comments about the derivation of the leach curve should be made.

1. It was proper to 'adjust' the daily leach data to account for the preg building period (days 141 to 165) and for the side-slope leaching (days 297 to 305). The shape of the curve has not been compromised. It still reflects the heap's metallurgical performance, but, without the operating fluctuations.

2. Deleting 25 days from the leach duration (from 408 days to 383 days) is acceptable. This was done to adjust for the preg building period (days 141 to 165) during which gold extraction was negative, i.e., there was a period of apparent preg robbing rather than gold extraction. Deleting the days leaves the 'adjusted' curve essentially unchanged, but, smoother.

3. There was a surge of gold extraction from the side slopes between days 301 and 343. The timing of this bulge of extraction near the end of a year's leaching is misleading. It should rightfully have occurred at the

beginning of the heap leach and that is where it has been moved when making the 'adjusted' leach curve.

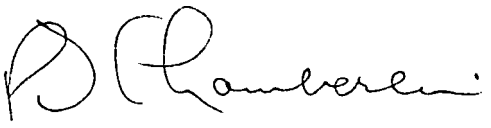
4. Method #3 uses only the data from the later stages of the leach curve. During this period there are fewer fluctuations in the data, the curve is flatter, and extrapolations into the future are more reliable.

5. When heaps are properly constructed, and this sulfide test heap was, they usually give better gold extraction than the column tests that represent them. This observation has been noted at many operations and on many ore types. The column test forecast with this sulfide ore was 55% extraction and it is not surprising to see forecasts of 57% to 62% based on the test heap.

6. The ore on the sulfide test heap was more sulfidic than the average orebody. This test heap was probably a worst case scenario.

The gold extraction from the sulfide test heap must be viewed as gratifying because it exceeded expectations.

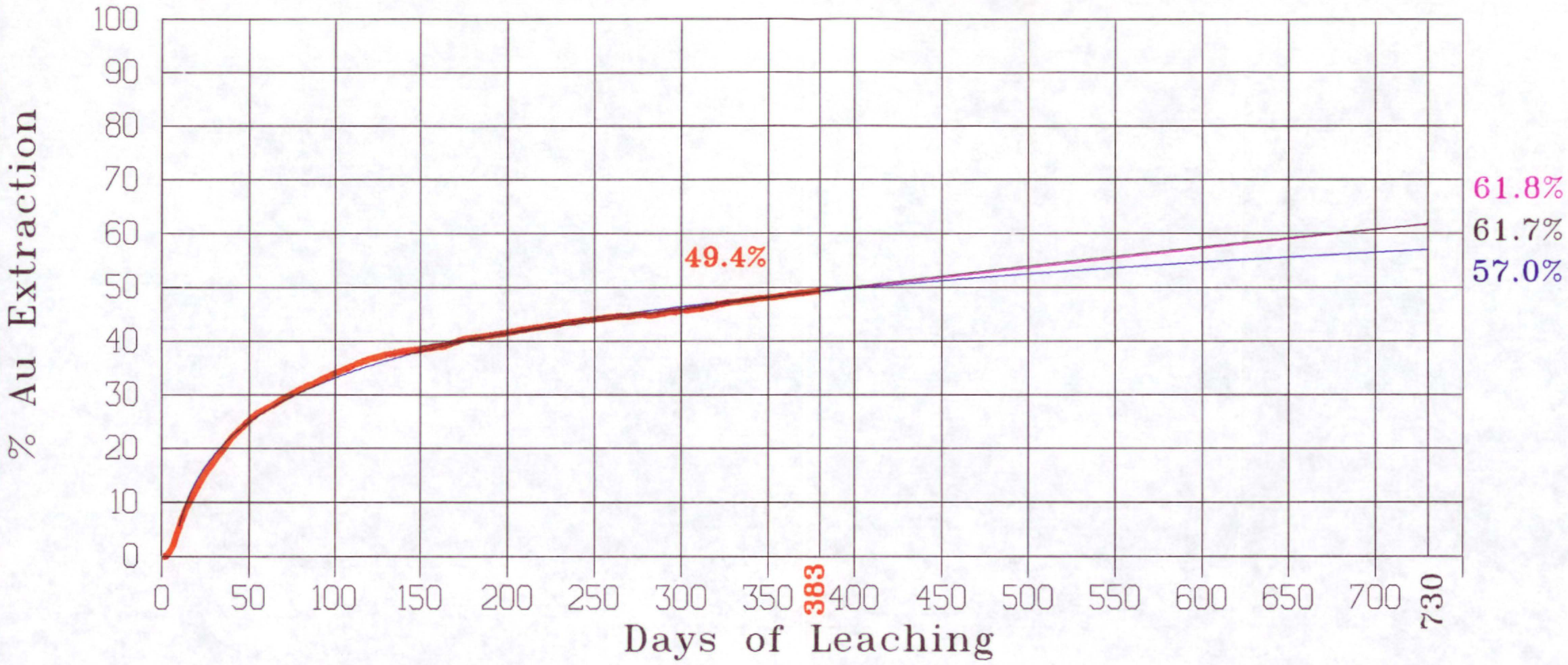
Respectfully yours,



Paul D. Chamberlin

SULFIDE TEST HEAP – GOLD EXTRACTION CURVES

ADJUSTED ACTUAL vs. EXTRAPOLATED (MODELS 1-3)



ADJUSTED ACTUAL

Extrapolation from MODEL 1 Regression: Days 10 – 383

Extrapolation from MODEL 2 Regression: Days 150 – 383

Extrapolation from MODEL 3 Regression: Days 129 – 383

FIGURE 4.2.2-1

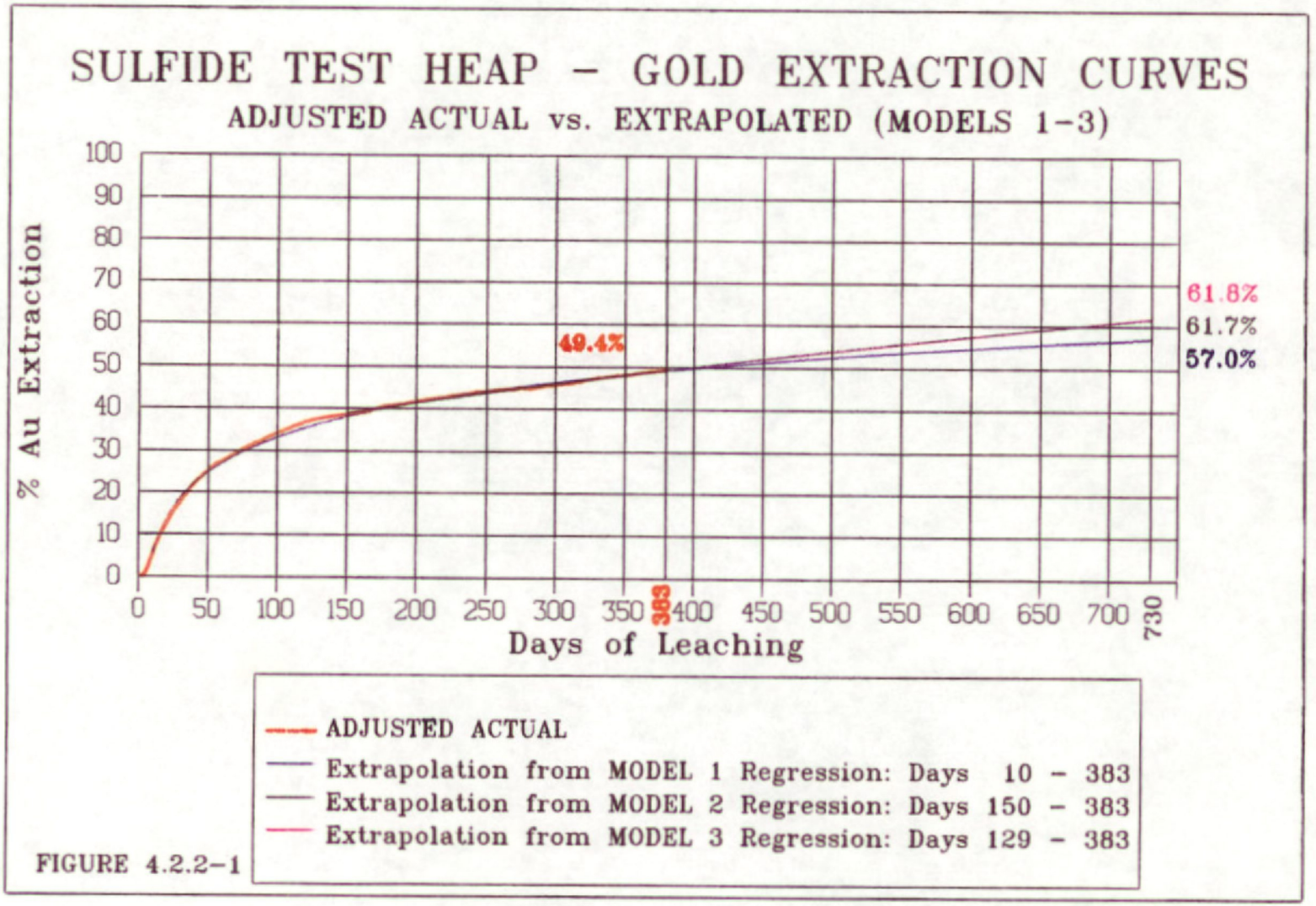

SULFIDE TEST HEAP - GOLD EXTRACTION CURVES
ADJUSTED ACTUAL vs. EXTRAPOLATED (MODELS 1-3)
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
383
400
450
500
550
600
650
700
730
Days of Leaching
49.4%
61.8%
61.7%
57.0%
ADJUSTED ACTUAL
Extrapolation from MODEL 1 Regression: Days 10 - 383
Extrapolation from MODEL 2 Regression: Days 150 - 383
Extrapolation from MODEL 3 Regression: Days 129 - 383

FIGURE 4.2.2-1

4.2 REGRESSION ANALYSIS

Regression Analysis was performed on the data from the Sulfide Test Heap in an attempt to predict the actual overall gold extraction at the end of a two year leach cycle. A theoretical prediction of 55%, developed prior to the commencement of the Sulfide Test Heap from column testwork done at Degerstrom Labs, had been used throughout the year of leaching for tracking purposes.

4.2.1 Actual Curve vs Adjusted Actual Curve

The actual gold extraction curve has two distinct areas of deviation from the curve slope. One occurs at about Day 150 and the other occurs at about Day 300 as illustrated in Figure 4.2.1-1.

The first area of deviation occurred when "preg building" was implemented in the processing stage. Gold content was allowed to concentrate in the process solution by not recovering it in the Merrill-Crowe Plant. During this period the "ON" solution gold grade actually assayed higher then the effluent solution grade coming off the heap. Because of this gold concentration gradient, the heap appeared to lose some gold extraction percentage. When the preg building ceased, the gold extraction rate rose sharply until an apparent equilibrium was again maintained (i.e. the slope resumed as it had before the preg building influence interval).

The second area of deviation occurred when the unleached side slopes were put under leach, Day 297-305. Due to the instability of the ore on the oversaturated sides during winter/spring 1992-1993, the side slopes were left off leach until July 1993. A steepened incline in the extraction slope occurred when the sides were put under leach.

An adjusted gold extraction curve was formulated in an attempt to smooth out the areas of deviation in the actual curve for regression analysis purposes.

During the preg building phase the percent gold extraction dropped off and then rose sharply. Since during this 25 day period, (Day 141-165), the data did not contribute to the overall extraction percentage, those days were simply deleted from the data base for the adjusted actual curve (Table 4.2.1-1).

When the side slopes were put under leach it is estimated that the gold extraction gained an additional 3.3% (Table 4.2.1-2). Since these slopes should have been on leach since the heap's conception, the additional extraction percentage was moved from Day 301-343 to Day 4-46. This better reflects the gold extraction for all of the test material from the beginning of the leach cycle rather than the unleached portions of ore being treated as a separate test (i.e. as though fresh ore was added in July).

4.2.2 Regression Analysis Models

The adjusted actual curve, as explained in Section 4.2.1, was used for the regression analysis models. Model 1 used data points from Day 10-383 and extrapolated to 57.0% gold extraction at the end of a two year leach cycle. Model 2 used data points from Day 150-383 and extrapolated to 61.7% gold extraction at the end of two years. Model 3 used data points from Day 129-383 and extrapolated to 61.8% gold extraction in the same time frame as Models 1 and 2 (Figure 4.2.2-1).

4.2.2.1 Model 1 - Arithmetic Gold Extraction Axis; Log Day Axis

$$y = (m * \log(x)) + b$$

When the actual and adjusted actual gold extraction curves are plotted on an arithmetic y-axis and log x-axis the curve becomes fairly linear (Figure 4.2.2.1-1). Therefore, I assumed that a meaningful linear regression analysis could be performed on the data points. I chose the adjusted actual curve since the deviations were smoothed out as explained in Section 4.2.1. Points (Days) 10-383 were chosen for the regression analysis since these data points gave the most linear fit.

Table 4.2.2.1-1 shows the regression output with a coefficient of determination (r^2) of 0.996 and a standard error of y estimate of 0.5597. This model estimates the Sulfide Test Heap gold extraction to reach 57.0% at the end of a two year leach time.

4.2.2.2 Model 2 - Log of Decreasing Tail Grade

$$y = 10^{(mx + b)}$$

In this model the gold ounces extracted were calculated from the adjusted curve cumulative percent gold extraction. The extracted gold ounces were subtracted from the total gold ounces contained giving the gold ounces left in the heap. The ounces left were divided by the total tons to give the heap's tail grade in ounces per ton. Since the log of the decreasing tail grade gave a semi- linear plot from Day 150-383, these data points were used for the linear regression analysis.

Table 4.2.2.2-1 shows the regression output with a coefficient of determination (r^2) of 0.992. This model estimates the Sulfide Test Heap gold extraction to be 61.7% at the end of two years on leach.

4.2.2.3 Model 3 - Least Squares Curve Fit

$$y = A + B*X + C/X$$

For Model 3, a software program named Curve Fit was used to analyze the data points. The program performs a least squares curve fit on x, y data. Curves for 25 equations are fitted. Equation coefficients, Correlation Coefficient, and Best Fit are computed. For any of the 25 equations, predictions for y can be calculated. Since the program will accept only 255 data points, Day 129-383 were used from the adjusted actual curve.

Equation 4, a combined linear and reciprocal equation was chosen by Curve Fit as the Best Fit with a coefficient of determination of 0.996 (Table 4.2.2.3-1). The regression output is shown in Table 4.2.2.3-2. This model predicts the Sulfide Test Heap gold extraction to reach 61.8% at the end of a two year leach period. This closely correlates with Model 2.

TABLE 4.2.1-1

Preg Building Influence Interval - Au Extraction Database		
Day	Cum % Au Extraction	Description
139	34.673	
140	34.707	
141	34.729	PB
142	34.735	*
143	34.737	*
144	34.651	*
145	34.518	*
146	34.379	*
147	34.233	*
148	34.105	*
149	34.004	*
150	33.909	*
151	33.838	*
152	33.819	*
153	33.909	*
154	34.058	*
155	34.170	*
156	34.287	*
157	34.340	*
158	34.371	*
159	34.436	*
160	34.479	*
161	34.554	*
162	34.612	*
163	34.662	*
164	34.699	*
165	34.722	*
166	34.748	
167	34.807	
168	34.846	
169	34.894	

PB = Preg Building

* = Preg Building Influence

TABLE 4.2.1-2

Percent Au Extraction Determination from Side Slope Contribution			
Day	Actual % Cum Extracted	Actual % Gain 12 Days	Description
12	5.8	5.8	
24	12.3	6.5	
36	17.1	4.8	
48	21.2	4.1	
60	24.1	2.9	
72	26.4	2.3	
84	28.4	2.0	
96	30.1	1.7	
108	31.8	1.7	
120	33.3	1.5	
132	34.3	1.0	
144	34.7	0.4	*
156	34.3	-0.5	*
168	34.8	0.5	*
180	35.3	0.5	*
192	36.1	0.8	*
204	37.2	1.1	*
216	37.7	0.5	@
228	38.4	0.7	@
240	39.1	0.7	@
252	39.6	0.5	@
264	40.2	0.6	@
276	40.8	0.6	@
288	41.2	0.4	@
300	41.5	0.3	@
312	43.3	1.8	-0.5
324	44.9	1.6	-0.5
336	45.9	1.0	-0.5
348	46.8	0.9	-0.5
360	47.4	0.6	#
372	48.0	0.6	#
384	48.4	0.4	#
396	48.9	0.5	#
408	49.4	0.5	#

PB = Preg Building
SS = Side Slopes (under leach)
• = Preg Building Influence
@ = After PB Influence and Before SS Influence
# = After SS Influence

Since •, @ and # time intervals all averaged +0.5% Au extraction/12 days, I assumed that the actual % extraction for each 12 day period during the side slope extraction period should be 0.5%. Therefore, I subtracted 0.5% from the actual extraction to determine what % should be attributed to the side slope recovery.

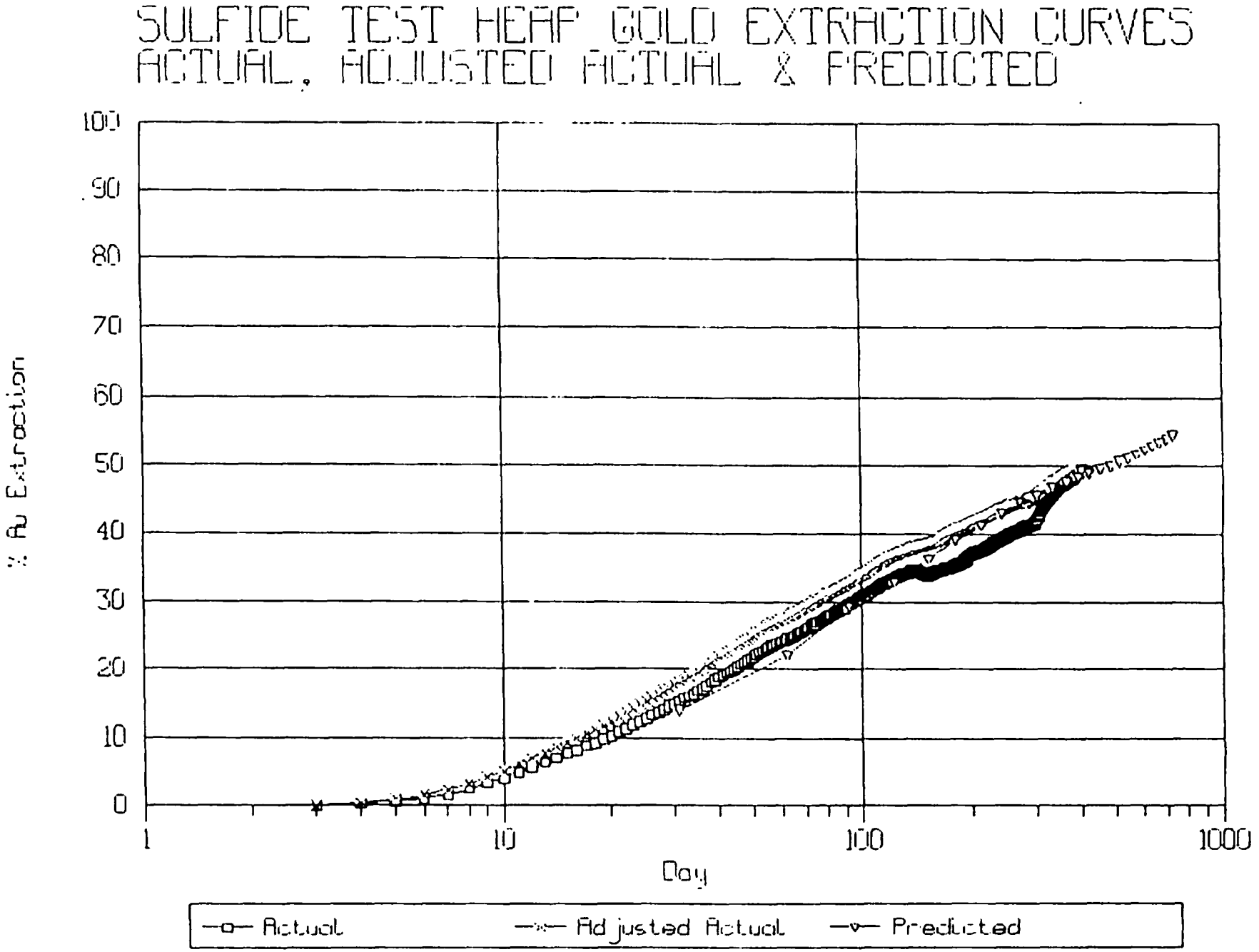


FIGURE 4.2.2.1-1

TABLE 4.2.2.1-1

REGRESSION ANALYSIS DATA - MODEL 1
Arithmetic Gold Extraction Axis; Log Day Axis
Adjusted Sulfide Test Heap Percent Gold Extraction Curve
Day 10-383

Regression Output

Constant		-22.0560
Std Err of Y Est		.5997
R^2 (Adj, Raw)	.9961415	.9961518
No. of Observations		374
Degrees of Freedom		372
Coefficient(s)		27.61450
Std. Err of Coef.		.0889875

Equation: $y = (m^* \log(x)) + b$
$m = 27.61450$
$b = -22.0560$
x = Day
y = % Au Extraction

		Adjusted Curve y Value:
If x = 50;	Then y = 24.9	25.1
If x = 100;	Then y = 33.2	34.0
If x = 150;	Then y = 38.0	38.4
If x = 200;	Then y = 41.5	41.5
If x = 250;	Then y = 44.2	44.0
If x = 300;	Then y = 46.4	45.6
If x = 350;	Then y = 48.2	48.0
If x = 400;	Then y = 49.8	
If x = 450;	Then y = 51.2	
If x = 500;	Then y = 52.5	
If x = 550;	Then y = 53.6	
If x = 600;	Then y = 54.7	
If x = 650;	Then y = 55.6	
If x = 700;	Then y = 56.5	
If x = 730;	Then y = 57.0	

TABLE 4.2.2.2-1

REGRESSION ANALYSIS DATA - MODEL 2
Log of Decreasing Tail Grade
Adjusted Sulfide Test Heap Percent Gold Extraction Curve
Day 150 - 383

Regression Output:

Constant		-1.38911
Std Err of Y Est		.0021
R^2 (Adj, Raw)	.9924772	.9925095
No. of Observations		234
Degrees of Freedom		232
Coefficient(s)		-0.000349
Std Err of Coef.		0.0000020

Equation: $y = 10^{(mx + b)}$
$m = -0.000349$
$b = -1.38911$
x = Day
y = % Au Extraction

		Adjusted Curve y Value
If x = 150;	Then y = 39.0	38.4
If x = 200;	Then y = 41.4	41.5
If x = 250;	Then y = 43.7	44.0
If x = 300;	Then y = 45.9	45.6
If x = 350;	Then y = 48.0	48.0
If x = 400;	Then y = 50.0	
If x = 450;	Then y = 51.7	
If x = 500	Then y = 53.9	
If x = 550;	Then y = 55.8	
If x = 600;	Then y = 57.5	
If x = 650;	Then y = 59.2	
If x = 700;	Then y = 60.8	
If x = 730;	Then y = 61.7	

TABLE 4.2.2.3-1

Curve Fit Equation Analysis

EQ#	COEF A	COEF B	COEF C	R ^2	R ^2 C	EQUATION
1	0.3204D+02	0.4533D-01	0.0000D+00	0.3302	0.3301	Y=A+B*X
2	0.0000D+00	0.1616D+00	0.0000D+00	0.0000	0.0000	Y=B*X
3	0.2923D-01	-.2448D-04	0.0000D+00	0.3735	0.3733	Y=1/(A+B*X)
4	0.3805D+02	0.3381D-01	-.6757D+03	0.3359	0.3359	Y=A+B*X+C/X
5	0.5414D+02	-.2408D+04	0.0000D+00	0.3552	0.3550	Y=A+B/X
6	0.1735D-01	0.1310D+01	0.0000D+00	0.3739	0.3738	Y=X/(A*X+B)
7	0.6153D+02	-.5789D+04	0.3502D+06	0.3917	0.3916	Y=A+B/X+C/X*X
8	0.2924D+02	0.6986D-01	-.4661D-04	0.3346	0.3345	Y=A+B*X+C*X*X
9	0.3076D+00	-.4948D-03	0.0000D+00	0.0000	0.0000	Y=A*X+B*X*X
10	0.1069D+02	0.2558D+00	0.0000D+00	0.3350	0.3349	Y=A*X^B
11	0.3331D+02	0.1001D+01	0.0000D+00	0.3833	0.3832	Y=A*B^X
12	0.5554D+02	0.4561D-24	0.0000D+00	0.3683	0.3688	Y=B^(1/X)
13	0.3464D+02	0.1620D-03	0.0000D+00	0.3784	0.3784	Y=A*X^(B*X)
14	0.5889D+02	-.1290D+02	0.0000D+00	0.3782	0.3781	Y=A*X^(B/X)
15	0.3331D+02	0.1059D-02	0.0000D+00	0.3833	0.3832	Y=A*e^(B*X)
16	0.5554D+02	-.5605D+02	0.0000D+00	0.3683	0.3688	Y=A*e^(B/X)
17	-.1698D+02	0.1105D+02	0.0000D+00	0.3914	0.3914	Y=A+B*lnX
18	0.5567D-01	-.5946D-02	0.0000D+00	0.3355	0.3355	Y=1/(A+B*lnX)
19	0.1326D+02	0.1000D+01	0.2071D+00	0.3357	0.3356	Y=A*B^X*X^C
20	0.8318D+01	0.6118D+04	0.2947D+00	0.3354	0.3354	Y=A*B^(1/X)*X^C
21	0.5206D+02	0.5703D+03	-.5937D+06	0.3341	0.3340	Y=A*e^(((X-B)^2)/C)
22	0.2016D+02	-.4703D+00	0.4622D+02	0.3355	0.3355	Y=A*e^(((lnX-B)^2/C)
24	0.7705D+02	0.4884D+04	0.2071D+00	0.3357	0.3356	Y=A*(X/B)^C*e^(x/b)
25	0.5308D-07	-.4866D+03	0.1986D-01	0.3333	0.3332	Y=1/(A*(X+B)^2+C)

BASED ON THE VALUE OF RC( )--BEST FITTING CURVE WAS NUMBER 4

TABLE 4.2.2.3-2

REGRESSION ANALYSIS DATA - MODEL 3
Least Squares Curve Fit
Adjusted Sulfide Test Heap Percent Gold Extraction Curve
Day 129 - 383

Regression Output:

R^2 .9959

Equation: $y = A+B*X+C/X$
$A = 0.3805D+02$
$B = 0.3381D-01$
$C = -.6757D+03$
x = Day
y = % Au Extraction

		Adjusted Curve y Value
If X = 150;	Then y = 38.6	38.4
If X = 200;	Then y = 41.4	41.5
If X = 250;	Then y = 43.8	44.0
If X = 300;	Then y = 45.9	45.6
If X = 350;	Then y = 48.0	48.0
If X = 400;	Then y = 49.9	
If X = 450;	Then y = 51.8	
If X = 500;	Then y = 53.6	
If X = 550;	Then y = 55.4	
If X = 600;	Then y = 57.2	
If X = 650;	Then y = 59.0	
If X = 700;	Then y = 60.8	
If X = 730;	Then y = 61.8	

Alan Bell

Please return to VTR.

THEODORE P. PASTER, Ph.D.
Consultant
11425 East Cimmarron Drive
Englewood, Colorado 80111
(303) 771-8219

Gold is in the fissures! May not be associated with pyrite / arsenopyrite.

February 19, 1994

Laura L. Damon
Brohm Mining Corporation
P.O. Box 485
Deadwood, SD. 57732

NO SIGN OF GOLD BEING ENCAPSULATED IN SILICA! Gypsum could be plugging the pores!

RE: Petrography of One Head and One Tail Heap Leach Test Sample for Brohm Mining Corporation.

Acid wash to get rid of gypsum

RESULTS

Introduction

The Head sample is from a sulfide heap leach test run over the past year. It was agglomerated with 150 lb limestone fines/ton ore. The Tail sample represents the same material after leaching.

Rock Type

The principal rock type appears to be a porphyritic trachyte or latite.

Rock Alteration

The only alterations seen are:

1) Some goethite development in the Head and Tail which is probably from weathering of sulfides in the rock.
2) Approximately 15% clay alteration of feldspar along cleavage and/or along cryptoperthite exsolution structure planes.

Because of the close gold association with clay, it is assumed that gold mineralization is coincident with this minor argillic alteration event. The copper mineralization appears to be a different, more vein-like, event.

Sulfides and Gold

Head:

Pyrite (Py); Approximately 3% cubic porphyroblasts dispersed through rock groundmass. Contains an opaque gray mineral as primary inclusions.
Arsenopyrite (Aspy); Minor amount as porphyroblasts.
Covellite; Minor or trace found embedded in goethite(?) with Py, Aspy and rutile.
Gold; $\leq$ 1u particles principally associated with clay in 10-20u alteration patches in K-spar (Probably cryptoperthite). Gold is not associated with covellite.

Tail:

Pyrite; Same description as in Head.
Chalcopyrite (Cupy); Two particles (trace), 0.1-0.4mm in size, which had been liberated form any associated minerals.
?; Found as 2-42u inclusions in Py. A gray, low-reflectance opaque mineral which may be galena, digenite or bornite. May possibly be a silver mineral but more likely Ag-bearing galena.
Gold; A significant amount of $\leq$ 1.5u Au particles are present associated with the clay alteration in the feldspar phenos but cavities are also lined with a fine-grained unidentified secondary mineral not found in Head sample.

Gold is not particularly associated with any other phase although it may be overlooked, at this size, as inclusions in Py and Cupy.

Leach Product

The unidentified fine-crystalline product found with clay and gold in the Tail which is not found in the Head may or may not be gypsum. It's crystal size is approximately 1 to 3 u which is too fine-grained to obtain most optical properties.

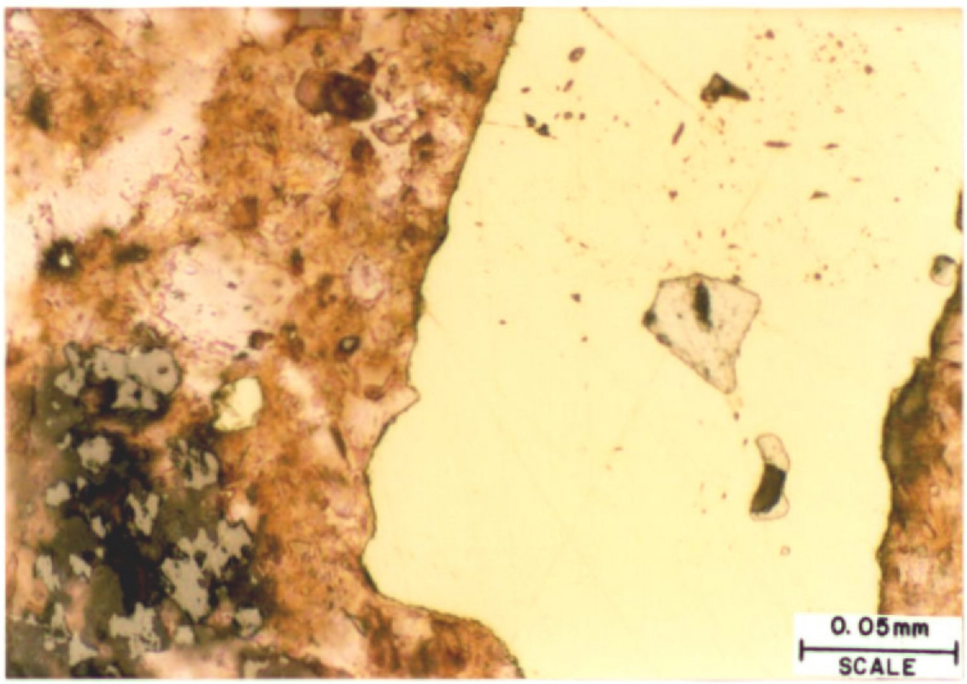
The precipitation of this mineral in the clay alteration crevices where the gold is found undoubtedly impedes fluid flow to the point where gold leaching stops.

Recommendations

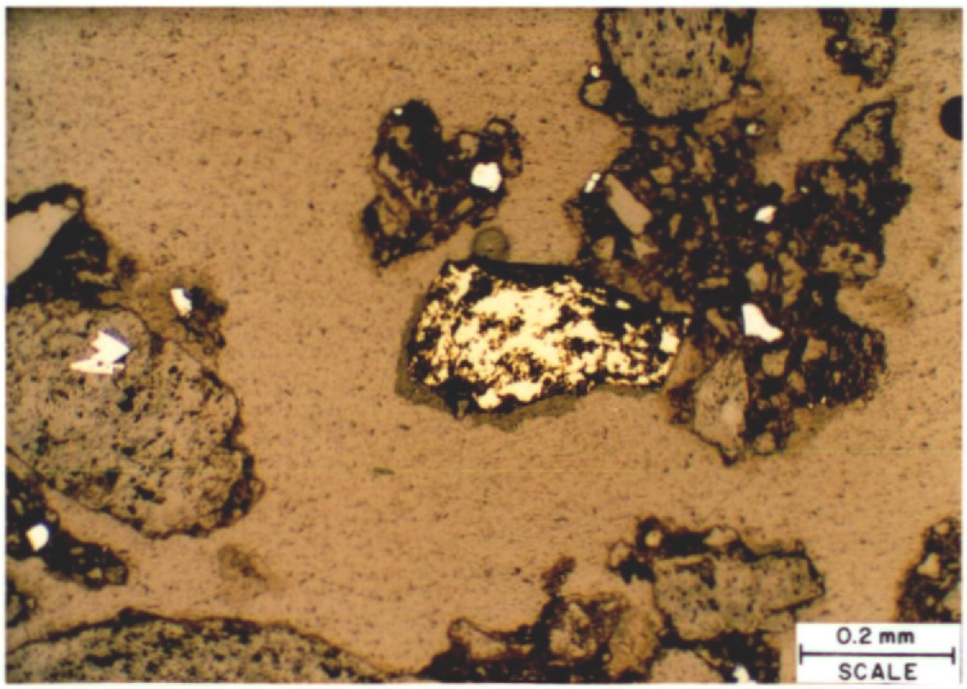
Microprobe identifications of the Py inclusions and the unidentified leach product can and should be performed. The polished thin sections prepared for this investigation would be sufficient for the probe work. This will be done!

Respectfully submitted:

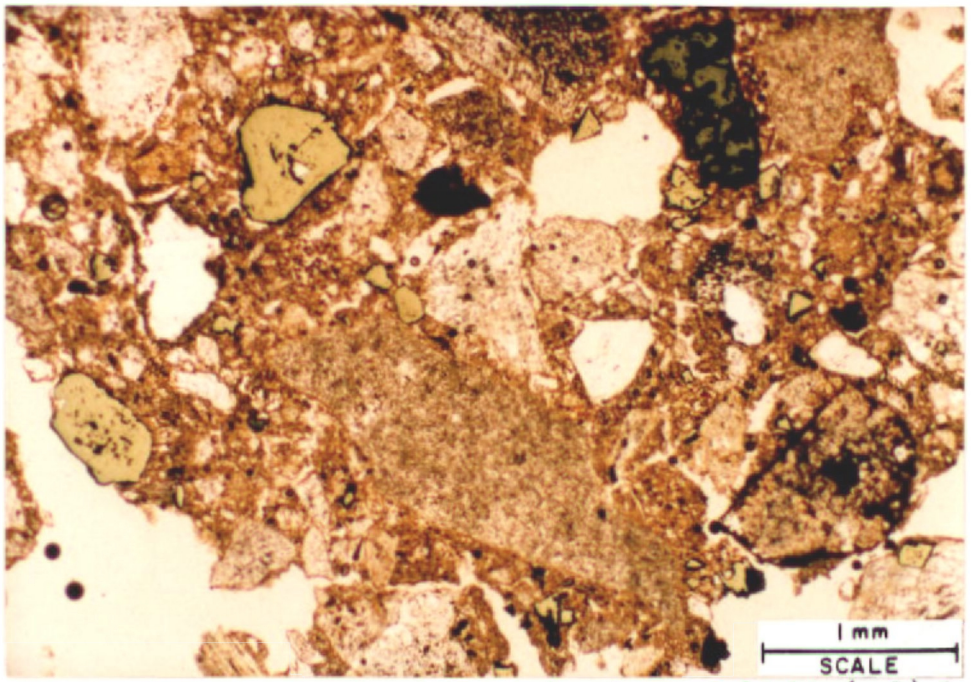
Theodore P. Paster
February 19, 1994



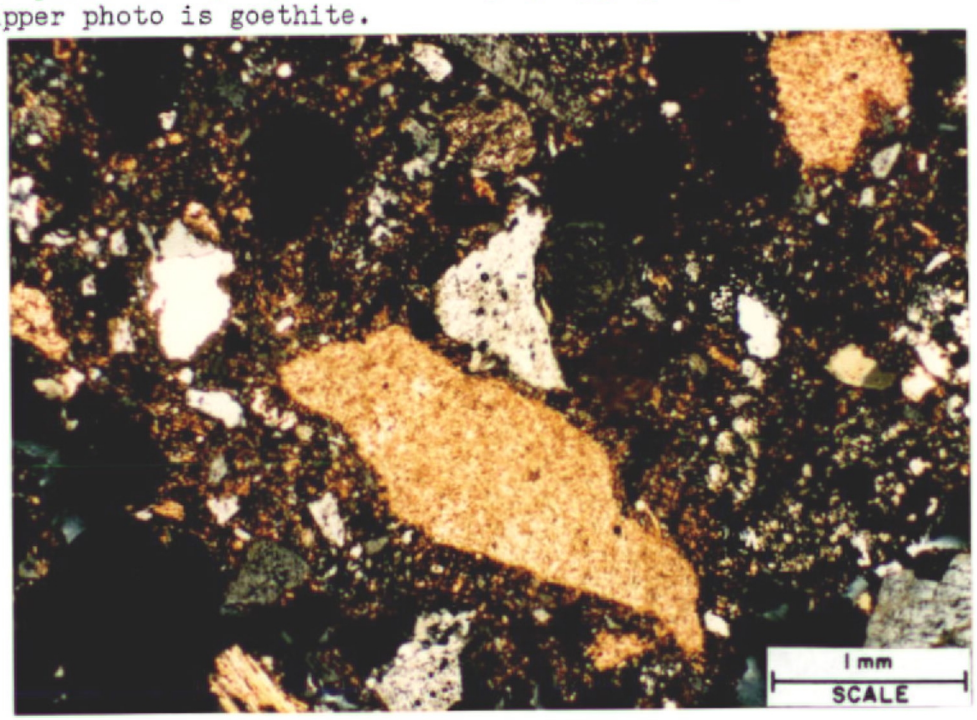
Tail, reflected light (rl) + plane polarized light (pl). Pyrite (Py) crystal in E½ of photo contains 10-42u inclusions of an unidentified gray, isotropic mineral which may be galena, bornite or digenite. Cluster of gray grains in SW corner is rutile.

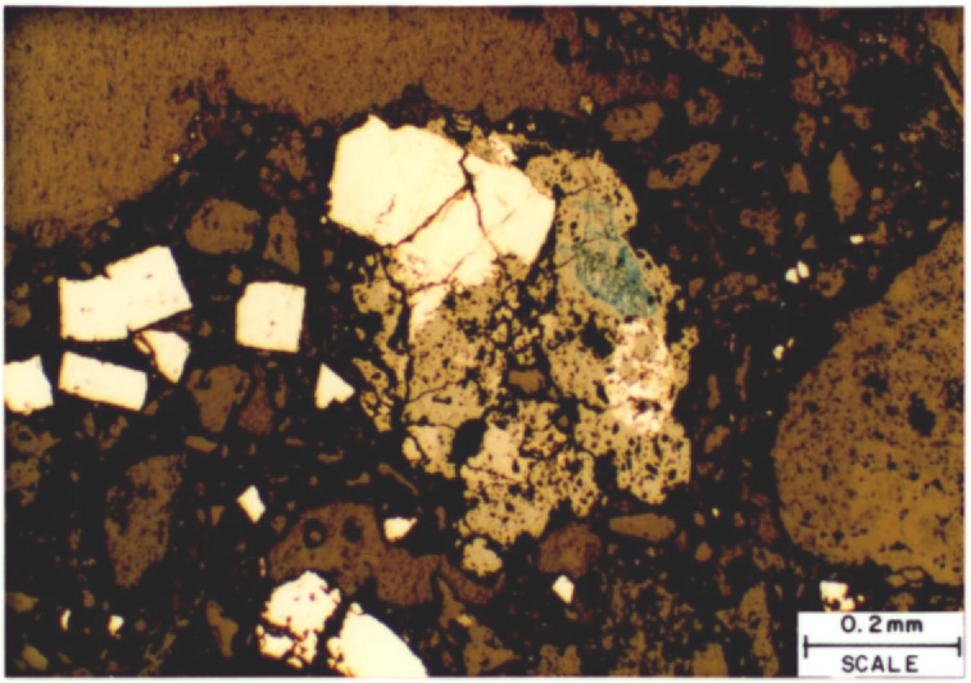


Tail, rl. Liberated chalcopyrite grain in center of photo. White Py crystals are scattered through mineral and agglomerate particles.

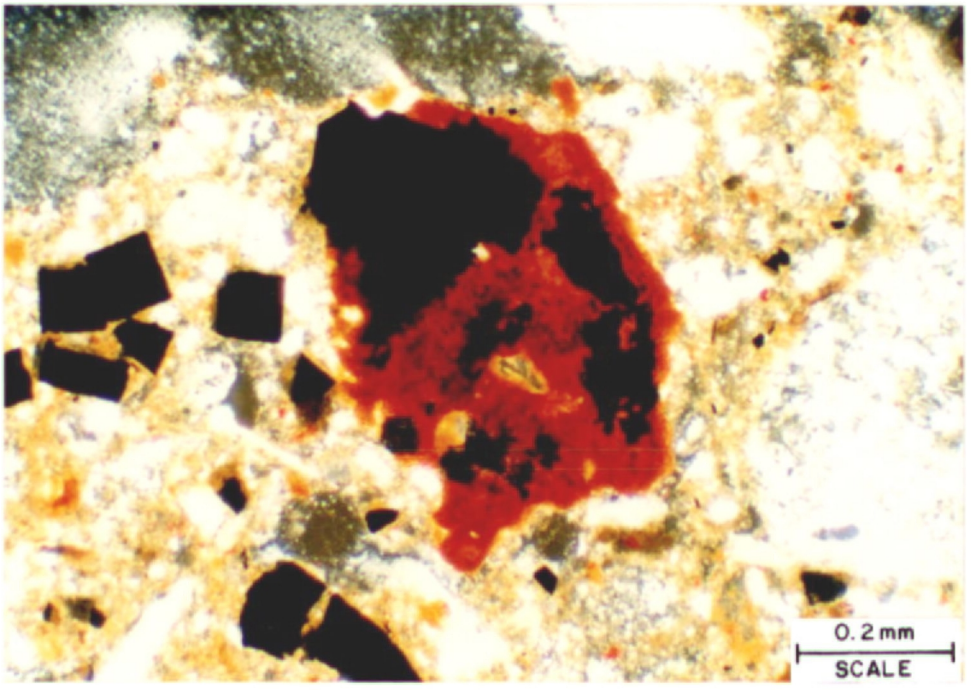


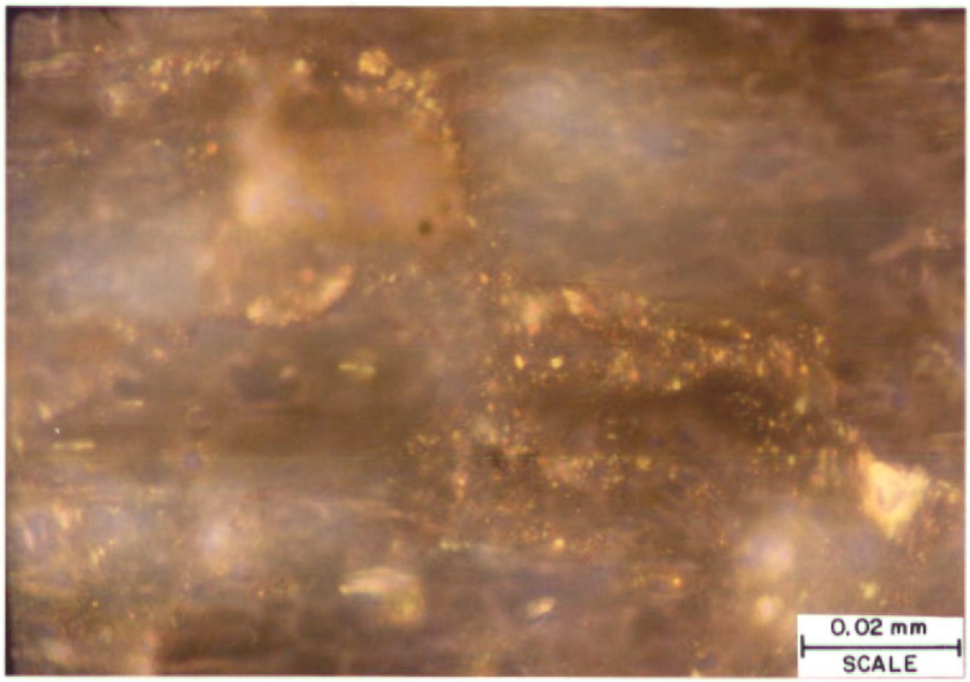
Tail, rl + pl upper photo and crossed polarized light (xpl) bottom photo; Same view in both photos. Note fractures and open cracks in agglomerate at top and lack of any sign of coatings in these cracks which would be the first locations for gypsum or other secondary minerals to precipitate. Pinkish fragments and dust particles in lower photo are limestone. Brass-colored crystals in upper photo are Py crystals. Dark gray aggregate grain near NE corner of upper photo is goethite.



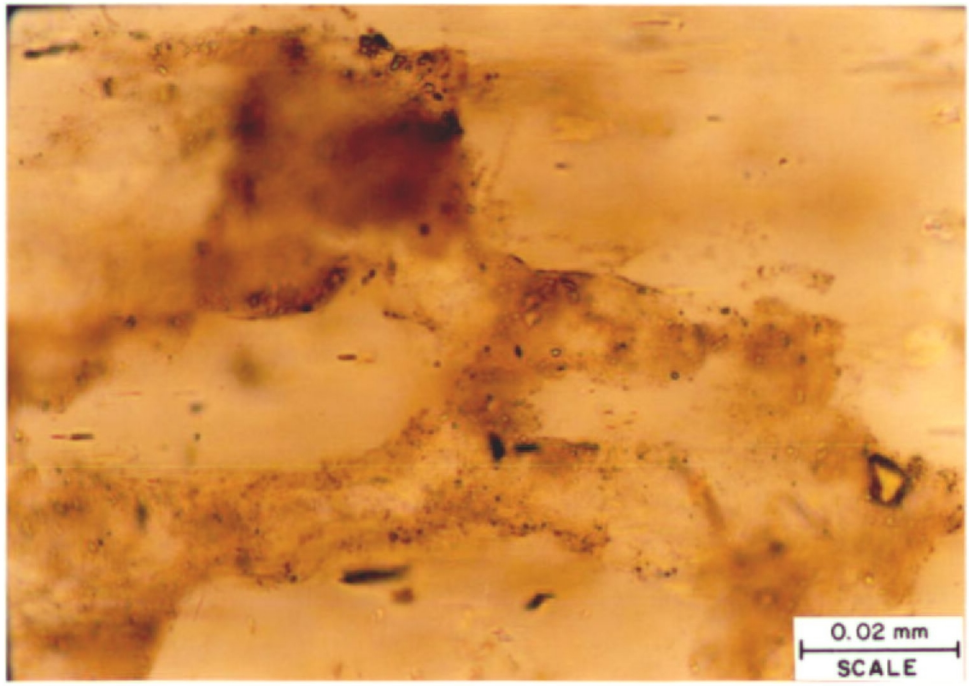


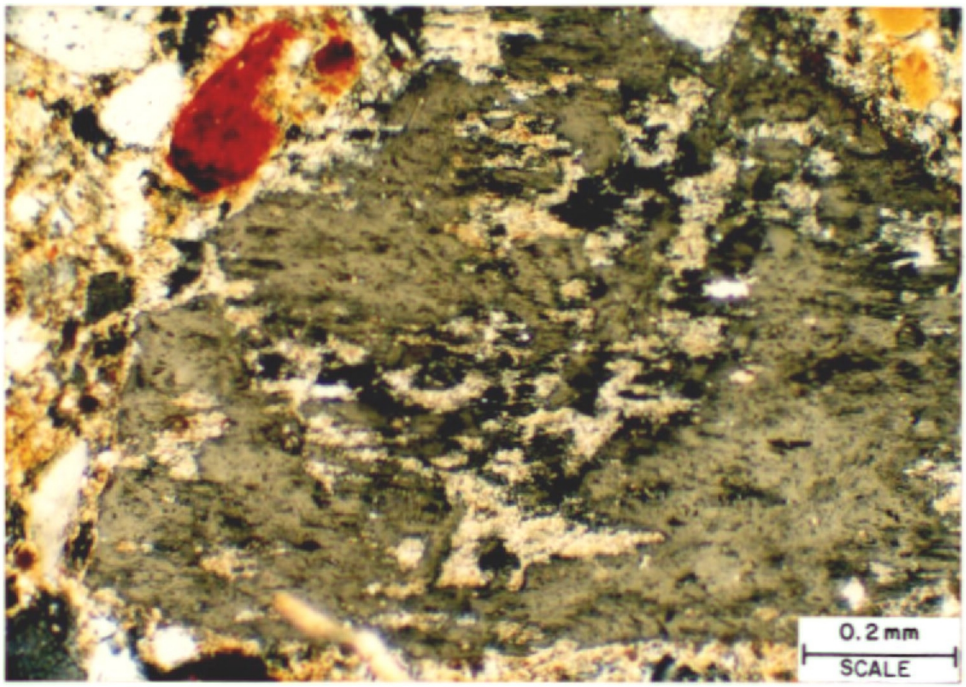
Head, rl upper photo and xpl lower photo; Same view in both photos. Upper photo shows blue covellite and yellow-white Py in gray goethite. Py crystals in surrounding agglomerate. Arsenopyrite is above and below Py crystal in goethite. Gold content in all of these phases is very low.



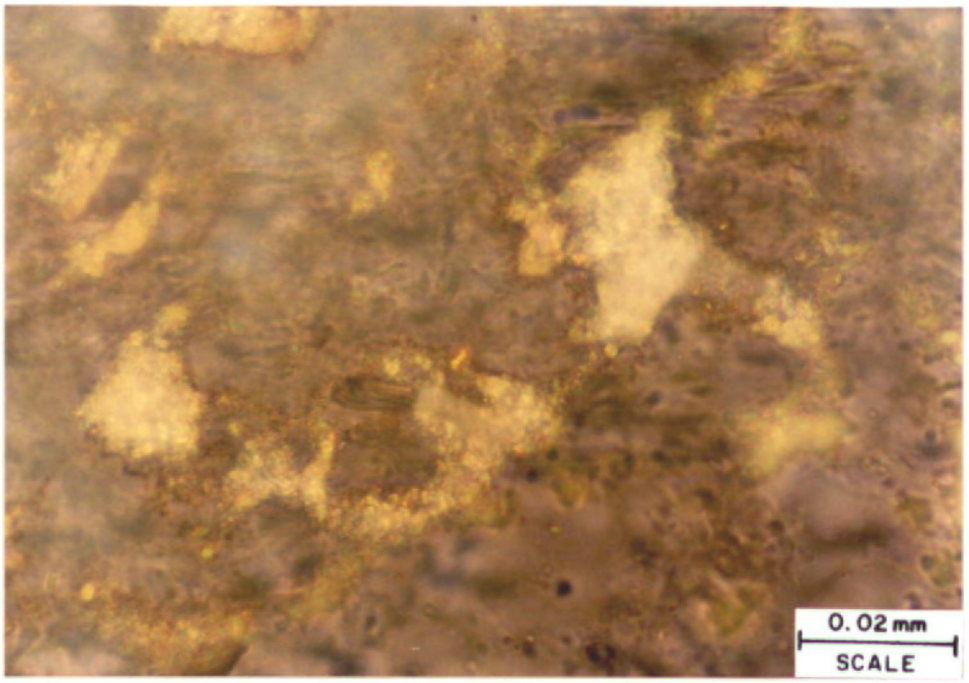


Head, rl upper photo and pl lower photo; Same view in both photos. ≤ 1u gold particles are associated with yellow rutile(?) grains in clay-altered patches in feldspar of upper photo. Clay alteration is shown as brownish discoloration in lower photo.

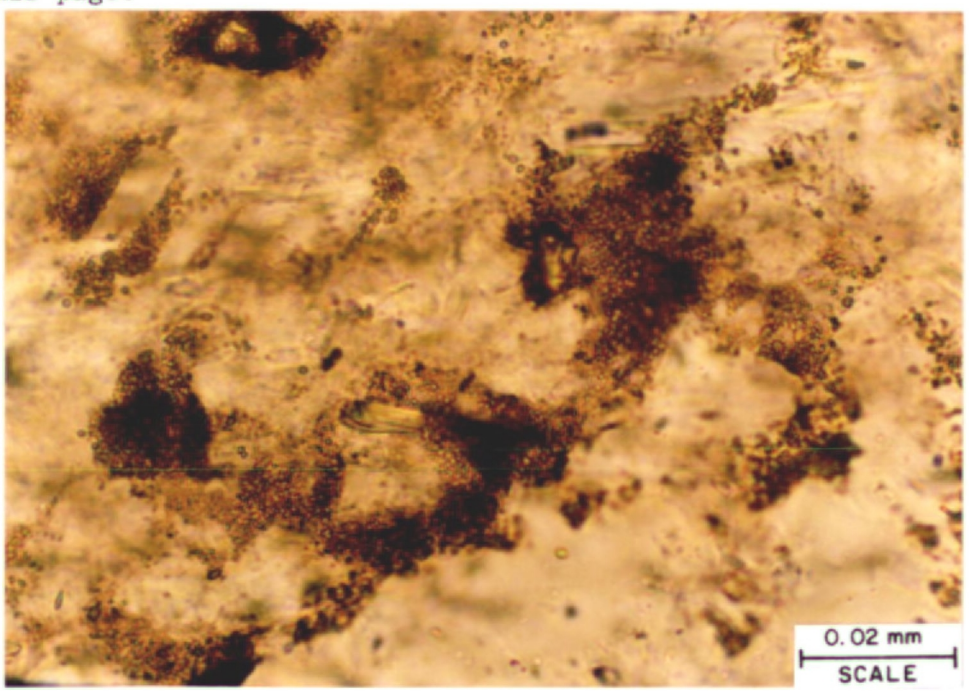


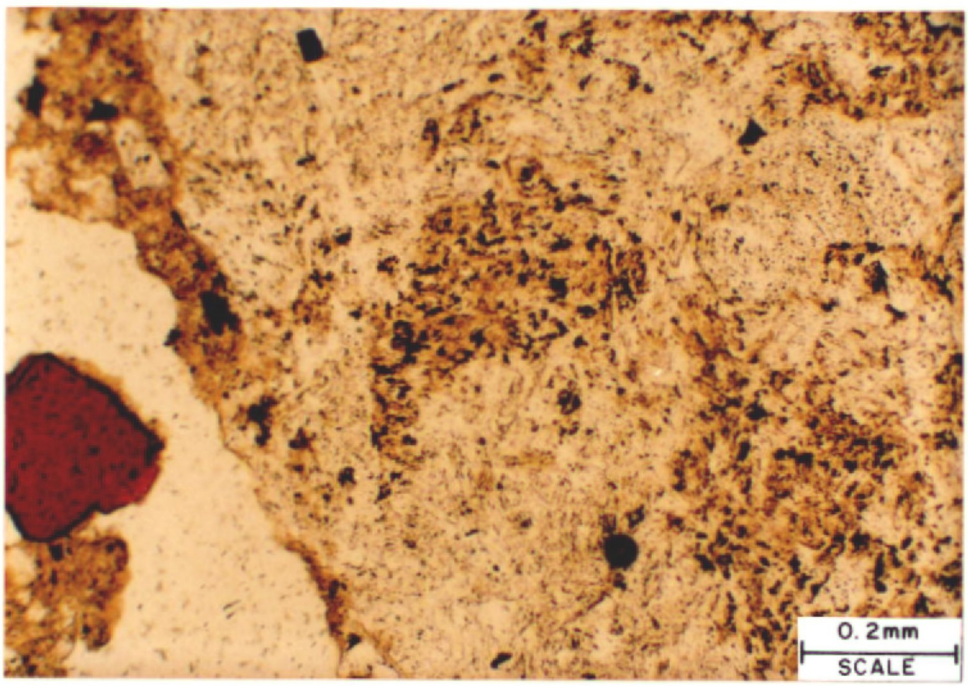


Head, xpl. low power view of photos on previous page which is in the center of this photo. large crystal of feldspar with patches of clay alteration.



Tail, rl upper photo and pl lower photo; Same view in both photos. Gold is clearly visible in top photo where largest (2u) gold particle is in center of photo. Yellowish unidentified crystals in top photo which occur in about 20u clumps line cavities which still contain clay but less noticable. Same crystals are brown in lower photo. Compare this set of photos with those of Head sample two pages prior to this page.





Tail, pl upper photo and xpl lower photo; Same view in both photos. Volcanic rock particle in which center of photo is low power view of gold-bearing clay/? replaced feldspar area shown on preceding page.